SUMMARY. Those who have read the foregoing will see that I hold the operation of craniotomy for idiocy to be still justifiable in a certain selected class of cases. I show that by perfected methods of operating the danger to life is under 5 per cent., and will probably become still less. The clinical reports quoted show improvement after operation too often for the facts to be ignored, even allowing for the happy therapeutic temperament of the operating surgeon; and in my personal experience one-half of the recovered cases have been improved.

The method by which improvement is brought about is largely a surgico-pedagogic one. All those who have had experience in educating idiots lay stress on the importance of special pedigogics, and craniotomy belongs, in a measure, to this class of therapeutic procedure. It may have some additional value by stimulating the circulation and nutritional activity of the brain.

The cases in which the operation is indicated are generally those of cerebral agenesis, rather than those having extensive sclerotic lesions and palsies. The operation may sometimes be repeated with benefit; and the results are not always immediate, especially so far as the cessation of the fits is concerned.

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THE INFLUENCE OF ALCOHOL AND ALCOHOLIC DRINKS UPON THE CHEMICAL PROCESSES OF DIGESTION.[1]

BY R. H. CHITTENDEN, PH.D.,
PROFESSOR OF PHYSIOLOGICAL CHEMISTRY IN YALE UNIVERSITY,

AND

LAFAYETTE B. MENDEL, PH.D.,
INSTRUCTOR IN PHYSIOLOGICAL CHEMISTRY.

IN considering the influence of alcohol and alcoholic drinks upon digestion we must have, at the outset, a clear understanding of what is meant by or included under the term digestion. Primarily, the object of digestion is to convert the insoluble and non-diffusible foodstuffs into forms capable of being absorbed. This is accomplished mainly through the agency of certain ferments or enzymes contained in the several digestive fluids, viz., the saliva, gastric juice, and pancreatic juice. The first of these fluids, secreted by three pairs of glands (salivary glands) which pour their secretions into the mouth, acts solely on starchy, farinaceous, or carbohydrate foods, transforming them into soluble dextrins and sugar—a process which commences in the mouth and continues for a short time in the stomach until the ferment of the saliva is finally destroyed by the increasing acidity of the gastric juice. The gastric juice, on the other hand, secreted by the tiny cells lining or composing the mucous membrane of the stomach, acts solely upon the proteid or albuminous foods, transforming them into a number of products characterized especially by their solubility and diffusibility. When the acid chyme leaves the stomach it passes through the pylorus into the small intestine, where it is exposed to the double action of the bile and pancreatic juice, the latter a powerful digestive fluid containing three distinct ferments. One of these ferments, an amylolytic enzyme, is apparently identical with the ferment of the saliva, and, like the latter, converts any unchanged starch into soluble dextrins and sugar. The second ferment is a powerful proteolytic enzyme called trypsin, which, in a neutral or alkaline solution, changes proteid matter into a row of soluble and diffusible products somewhat different in nature from those formed in acid gastric digestion. The third ferment is an adipolytic or fat-splitting ferment, which apparently transforms at least a portion of the fats of the food into soluble forms. This threefold action of the pancreatic juice may continue for some time in the small intestine, but as the peristaltic or wave-like contraction of the intestinal walls tends to push the contents of the tube onward toward the large intestine, and as absorption is quite rapid at this point, the conditions gradually become unfavorable for digestive action. The fluid and soluble matter is gradually absorbed into the blood and chyle, the contents of the intestine thereby becoming more or less viscous and compact, while the onset of fermentative and putrefactive changes gives rise to an acid reaction, all of which is inimical to the continuation of pancreatic digestion.

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[1] A report presented to the "Committee of Fifty for the Investigation of the Liquor Problem," at a meeting held in New York, May 3, 1895.

This briefly represents, in a general way, the character of the changes induced by the several digestive juices—chemical changes in the character of the various foodstuffs induced by the several digestive ferments or enzymes, and which are absolutely essential for the advantageous utilization of the food by the body. It is quite evident, however, that the rate and extent of digestion may be modified by a variety of circumstances, and these are by no means limited to the action of the respective ferments or enzymes. Thus, the process of secretion in a given set of glands may be so modified that the yield of digestive fluid is greatly reduced, thus diminishing the amount of fluid available for digestion; or the secretion may be so modified in composition that it is less adapted for carrying out its normal function. On the other hand, there may be an increased secretion of the digestive fluid by which digestion is accelerated through the mere increase in volume of the active fluid, or the strength of the secretion may be increased, thus leading to more vigorous digestive action. Such changes may be induced by an influence exerted through the nervous system, for, as is well known, secretion is more or less controlled, both as regards the quantity and composition of the fluid, by certain nerve-fibres; and thus an agent may have an important influence upon digestion through its influence upon certain parts of the nervous system, by which the activity of the secreting gland is controlled and modified, and this quite independent of any specific action the agent may exert, by its mere presence, upon the chemical or solvent action of the secretion or its contained ferment.

Again, as is well known, excessive accumulation of the products of digestion tends to retard or even check the rate of digestion through an inhibitory influence upon the activity of the ferment, hence modifications in the rate of absorption have a direct influence upon the digestive process. Consequently, an agent which by its mere presence in the stomach-contents, for example, is without direct action on the ferment, or even without influence when absorbed into the blood on the process of secretion, may indirectly influence digestion by either retarding or accelerating absorption. Further, the mechanical movements of the gastro-intestinal tube, *i. e.*, peristalsis, have their influence upon digestion, solution of the proteid foods especially being facilitated by the vigorous churning to which the contents of the stomach and intestine are subjected under normal circumstances. The onward movement of the contents of the alimentary tract is likewise governed by the proper contraction of the longitudinal and circular muscle-fibres of the intestine, and as all of these muscles, both of the stomach and intestine, are controlled by the nervous system, it follows that digestion may be somewhat modified through this channel, indirectly to be sure, but to quite an appreciable extent. Hence certain agents, acting primarily upon the nervous system, may indirectly in this manner have an influence upon digestion without showing any special action upon the digestive enzymes, or upon the process of secretion or absorption.

From these brief statements it is evident that what we term digestion is a complicated chemico-physiological process involving not only the simple solvent or digestive action of the several digestive juices, or of their contained ferments or enzymes, but dependent in no small degree for its successful working upon the kindred processes of secretion, absorption, etc. Hence, in attempting any accurate and complete study of the influence of alcohol and alcoholic fluids upon digestion, there must be a clear recognition of the fact that no single line of experimentation can lead to full and concise results covering the whole ground of inquiry. For experimental purposes, therefore, the subject must be studied under several distinct heads, as (1) the influence of alcohol and alcoholic drinks upon the process of secretion; (2) upon the process of absorption; (3) upon peristalsis; and (4) upon the purely chemical processes of digestion. It is the latter phase of the subject which has been our study during the past year, and the report which we now offer covers simply the influence of alcohol and a variety of alcoholic drinks upon the digestive action of the several digestive fluids and their contained ferments or enzymes. Such a study cannot properly be carried out on animals nor on human beings, since it would then be almost impossible to connect the results obtained with their true cause. We must at first exclude all of the accessory influences connected with secretion, absorption, and peristalsis if we are to learn the influence of alcoholic drinks upon digestive action, and this is best done by artificial digestive experiments in which saliva, gastric juice, and pancreatic juice are allowed to act under definite and constant conditions upon the several foodstuffs, and any variations in activity carefully determined. In this way, and in this way only, in our opinion, is it possible to measure the exact influence of alcohol and alcoholic fluids upon digestive action; *i. e.*, upon the purely chemical processes of digestion.

Before proceeding further, we would call attention to the fact that in writing this report we have confined ourselves mainly to a mere statement of the results obtained in our work, with the obvious conclusions to be drawn therefrom. In only a few instances have we attempted any comparison with the results obtained by other workers in this direction, and, as a rule, we have refrained from generalizations other than those plainly warranted by the data which we ourselves have obtained. At the end of our report we have appended a short bibliography giving the more important papers by previous workers.

GASTRIC DIGESTION (*i. e.*, PROTEOLYSIS BY PEPSIN-HYDROCHLORIC ACID).

The solvent action of the gastric juice on proteid or albuminous foods is due solely to the presence of pepsin-hydrochloric acid, but the amount of both pepsin and acid in the natural secretion varies considerably with different states of the system. The average amount of hydrochloric acid, however, is approximately 0.2 per cent, while to the pepsin no definite figure can be given, since as yet the chemist has not been able to isolate the ferment in a pure state. Further, it is quite certain that both ferment and acid are subject to great variation in the amount present in the secretion at different stages of digestion and under different conditions of health and nutrition. In view of these facts we have experimented under varying conditions in order that our results may have as wide an application as possible.

The methods pursued were as follows:

(*a*) *With fluid egg-albumin.*[1] The albumin solution was prepared after the method recommended by Schütz.[1] A quantity of undiluted white of egg was freed from globulin by the addition of hydrochloric acid of specific gravity 1.12 (4.2 c.c. acid to 300 c.c. of albumin), the mixture shaken vigorously, and after standing some hours filtered through paper. The clear acid fluid was then made exactly neutral with dilute sodium carbonate, after which it is ready for use. Ten c.c. of this fluid contain a little less than 1 gram of coagulable proteid, the exact amount being determined by heat-precipitation, collecting the coagulum on a weighed filter and drying at 110° C.

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[1] See R. H. Chittenden: "Observations on the Digestive Ferments;" Medical News, Philadelphia, February 16, 1889.

The digestive experiments were made in series, each individual mixture containing the same volume of the prepared albumin solution (10–20 c.c.), together with the same amount of pepsin and acid. The albumin solution was introduced into a small flask of 200 c.c. capacity provided with a suitable stopper, water and alcohol or alcoholic fluid being added to make the volume up to 50 c.c.

Lastly, 50 c.c. of 0.4 per cent. hydrochloric acid, containing a known amount of pepsin, were added, making the total volume of each mixture 100 c.c., and the strength of acid 0.2 per cent. HCl. It is thus evident that the only variable element in the mixtures of a given series is the amount of alcohol or alcoholic fluid present. The flasks were then placed in a water-bath, kept approximately at the body temperature (38–40° C.) for a definite period—usually five to seven hours. At the end of the allotted time, the extent of digestive action was determined by simply heating the mixtures to boiling, neutralizing the acid fluid by addition of an equivalent amount of sodium carbonate in a 1 per cent. solution, and collecting the precipitate of unaltered albumin or acid-albumin on a weighed filter, washing it with boiling water until free from chlorides, and then drying at 110° C. until of constant weight. The difference between the weight of coagulable albumin introduced and the amount found at the end of the experiment gives the amount of soluble digestive products, *i. e.*, albumoses and peptones, formed under the conditions of the experiment. In this way it is possible to measure accurately the extent of proteolytic action under varying conditions.

(*b*) *With coagulated blood-fibrin.* Fresh blood-fibrin from the blood of oxen or sheep was washed with water until quite white, then boiled repeatedly with water, after which it was thoroughly extracted with cold alcohol, boiling alcohol, and, lastly, with ether. It was then ground to a coarse powder and passed through a sieve, so constructed that the particles collected were all approximately of the same size. The so-prepared powder was then dried at 110° C. until of constant weight.

The digestive experiments with this form of proteid matter were conducted as follows: A definite amount of alcohol or alcoholic fluid was introduced into each flask, water being added to make the volume 50 c.c. Then 50 c.c. of 0.4 per cent. hydrochloric acid containing a known amount of pepsin were added, thus making the total volume of fluid 100 c.c. To this mixture two grams of the prepared fibrin were added. Thus, as in the experiments with fluid egg-albumin, all of the mixtures of a given series were exactly alike in containing the same volume of 0.2 per cent. hydrochloric acid, the same amount of pepsin, etc., but unlike in the percentage of alcohol or alcoholic fluid present. For comparison, one mixture of each series contained no alcohol whatever. When prepared, the mixtures of a given series were placed in a bath at 38°–40° C. for two to three hours, where they were kept under exactly the same conditions, being stirred or shaken to the same extent, etc. At the end of the given period the mixtures were heated to boiling to destroy the ferment, after which the undigested residue was collected on a weighed filter, washed with boiling water until free from all soluble matter, then dried at 110° C. until of constant weight. The difference between the weight of the fibrin taken and the undissolved residue is a true measure of the digestive action under the conditions of the experiment.

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[1] Zeitschr. f. physiol. Chem., Band ix. p. 581.

ACTION OF ABSOLUTE ALCOHOL (99.5–100 PER CENT.).

The percentages of alcohol referred to are percentages by volume unless otherwise specified. The pepsin employed was a very active scale pepsin marked 1:4000.

Experiment 1.

Conditions:

Proteid = fluid egg-albumin (20 c.c.).
20 c.c. albumin solution contain 1.6398 grams dry albumin.
0.03 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion 6$\frac{11}{12}$ hours at 38°–40° C.

Alcohol.	Undigested albumin.	Proteid digested.	Relative proteolytic action.[1]
0 per cent.	0.1850 gram.	88.8 per cent.	100.0
6 “	0.2708 “	83.5 “	94.0
12 “	0.5473 “	66.7 “	76.0
18 “	0.6703 “	59.2 “	66.6

Experiment 2.

Conditions:

Proteid = fluid egg-albumin (15 c.c.).
15 c.c. albumin solution contain 1.0522 grams dry albumin.
0.0024 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion 5⅓ hours at 38°–40° C.

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[1] Expressing the relative extent of digestive action as compared with the action of the control-experiment, the latter being taken as 100.

Alcohol.	Undigested albumin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.4007 gram.	62.0 per cent.	100.0
1 "	0.4075 "	61.3 "	98.8
3 "	0.5146 "	51.1 "	82.4
6 "	0.6256 "	40.6 "	65.4

Experiment 3.

Conditions:

Proteid = fluid egg-albumin (10 c.c.).
10 c.c. albumin solution contain 0.8199 gram dry albumin.
0.03 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion 5½ hours at 38°–40° C.

Alcohol.	Undigested albumin.	Proteid digested.	Relative proteolytic action.
0 per cent.	trace	100.0 per cent.	100.0
1 "	0.0100 gram.	98.8 "	98.8
3 "	0.0130 "	98.5 "	98.5
5 "	0.0250 "	97.0 "	97.0
8 "	0.0699 "	91.5 "	91.5
10 "	0.0875 "	89.4 "	89.4

Experiment 4.

Conditions:

Proteid = fluid egg-albumin (20 c.c.).
20 c.c. albumin solution contain 1.9198 grams dry albumin.
0.05 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion 5½ hours at 38°–40° C.

Alcohol.	Undigested albumin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.0887 gram.	95.4 per cent.	100.0
1 "	0.0740 "	96.1 "	100.8
5 "	0.2617 "	86.4 "	90.5
10 "	0.5373 "	72.0 "	75.5
15 "	0.5859 "	69.5 "	72.8

Experiment 5.

Conditions:

Proteid = blood-fibrin (2 grams).
0.016 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion 2¼ hours at 38°–40° C.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.5834 gram.	70.9 per cent.	100.0
1 "	0.5727 "	71.4 "	100.7
3 "	0.6273 "	68.7 "	96.8
5 "	0.6493 "	67.6 "	95.3

The following five series of experiments were all made after the same plan, each mixture containing 2 grams of blood-fibrin, 0.016 gram pepsin in 0.2 per cent. hydrochloric acid, and warmed at 38°–40° C. for 2¼ hours:

Experiment 6.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3676 gram.	81.7 per cent.	100.0
10 "	0.5970[1] "	70.2 "	85.9

Experiment 7.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.2013 gram.	90.0 per cent.	100.0
5 "	0.2601 "	87.0 "	96.6

Experiment 8.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.1759 gram.	91.3 per cent.	100.0
5 "	0.2145 "	89.3 "	97.8

Experiment 9.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.2027 gram.	89.9 per cent.	100.0
5 "	0.2619 "	87.0 "	96.7

Experiment 10.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3881 gram.	80.6 per cent.	100.0
4 "	0.4118 "	79.5 "	98.6

In the following three experiments the conditions were the same as in the preceding, excepting that the mixtures were warmed at 38°–40° C. for 2 hours instead of 2¼ hours:

Experiment 11.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.5315 gram.	73.5 per cent.	100.0
2 "	0.5390 "	73.1 "	99.4

Experiment 12.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.4630 gram.	76.9 per cent.	100.0
2 "	0.4583 "	77.1 "	100.2

Experiment 13.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.1970 gram.	90.2 per cent.	100.0
5 "	0.2830 "	85.9 "	95.2

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[1] Filtered very slowly and could not be washed thoroughly, hence the result is only approximately correct.

In the following three experiments the conditions were the same as in the preceding, except that the mixtures were warmed at 38°–40° C. for 1¾ hours:

Experiment 14.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.5068 gram.	74.7 per cent.	100.0
2 "	0.4970 "	75.2 "	100.6

Experiment 15.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.2032 gram.	89.9 per cent.	100.0
5 "	0.2317 "	88.5 "	98.4

Experiment 16.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3247 gram.	83 8 per cent.	100.0
5 "	0.3554 "	82.3 "	98.2

In the following two experiments the mixtures were warmed at 38°–40° C. for 1½ hours:

Experiment 17.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3361 gram.	83.2 per cent.	100.0
5 "	0.4040 "	79.8 "	95.9

Experiment 18.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3867 gram.	80.7 per cent.	100 0
5 "	0.4352 "	78.3 "	97.0

In the following experiment the conditions were apparently much the same as in the preceding experiments, although the results show a greater degree of retardation with like percentages of alcohol:

Experiment 19.

Conditions:

Proteid = blood-fibrin (2 grams).
0.02 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion 2¼ hours at 38°–40° C.

Alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.4536 gram.	77.32 per cent.	100.0
0.5 "	0.4688 "	76.56 "	99.0
1.0 "	0.4954 "	75.23 "	97.2
2.0 "	0.4958 "	75.21 "	97.2
3.0 "	0.5324 "	73.38 "	94.9
5.0 "	0.6031 "	69.84 "	90.3

A careful study of all of the preceding results makes it evident that we cannot define with mathematical exactness the action of a given percentage of absolute alcohol on pepsin-proteolysis, since variations in the attendant conditions, *i. e.*, the relative amounts of pepsin, acid, and proteid, together with the period of digestion, the digestibility of the particular proteid, etc., are prone to modify the final result. Thus, with a weak gastric juice, where the amount of ferment present is small and digestive action consequently slow, or where the proteid material used is difficult of digestion, the retarding effect of a given percentage of alcohol is far greater than when the digestive fluid is more active; that is, when it contains more pepsin. (Contrast Experiments 1, 2, and 3.) Further, this difference of action is more pronounced the larger the percentage of alcohol present. Thus, in Experiments 2 and 3, where the difference in the amount of pepsin present is very great, the action of 1 per cent. of absolute alcohol is essentially the same; but when the amount of alcohol is raised to 3, 5, or 6 per cent. then the difference in digestive action is very striking.

Bearing in mind the possibility of these variations incidental to variations in the attendant conditions, and recognizing the possibility and probability of just such variations in the human stomach, we may look at our results with a view to drawing some general conclusions. First, it is plainly manifest that in the presence of small amounts of alcohol (1–2 per cent. of absolute alcohol) gastric digestion may proceed as well or even better than under normal circumstances. In fact, many of our experiments show a slight increase in digestive power when the mixture contains 1 or 2 per cent. of absolute alcohol. This increased digestive action, though slight, occurs too frequently to be the result of mere accident, and apparently indicates a tendency for alcohol, when present in small quantity, to increase slightly the digestive action of pepsin-hydrochloric acid; or, in other words, to so stimulate the ferment that it can accomplish somewhat more, under given conditions, than it otherwise could do. As the percentage of alcohol is raised, retardation or inhibition becomes more noticeable, although ordinarily it is not very pronounced until the digestive mixture contains 5–10 per cent. or more of absolute alcohol. With 15–18 per cent. of absolute alcohol, digestive action may be reduced one quarter or even one-third, the exact amount of retardation, however, being especially dependent upon the strength or activity of the gastric juice and upon the natural digestibility of the proteid material. (See Experiments 1, 3, 4, and 6.) It is to be remembered, however, that 18 per cent. of absolute alcohol would be equivalent to 36 per cent. of proof-spirit, so that if we should assume the contents of a human stomach at a given period to be one-third proof-spirit, it might perhaps be considered that digestive action would be retarded to the extent of 25–35 per cent., provided the gastric juice present in the stomach was of fair strength and the proteid matter of ordinary digestibility. Such percentages of proof-spirit, however, are not likely to be long present in the stomach, and it is perhaps idle to speculate on such hypothetical cases. We may in this connection, however, again emphasize the fact that the stronger the gastric juice and the more digestible the proteid food undergoing digestion the less retardation will a given percentage of alcohol produce, while, on the other hand, the weaker the gastric juice and the more indigestible the proteid the greater will be the inhibition caused by a given percentage of alcohol. In other words, those variations which must naturally exist in the stomach-contents of different individuals, both in health and disease, will lead to different degrees of retardation in the presence of given percentages of absolute alcohol. It would, therefore, be unwise to make a general specific statement regarding the action of a given percentage of alcohol. Under definite conditions, however, as our experiments plainly show, the presence of a definite amount of alcohol always leads to essentially the same results.

In order to prevent any misinterpretation of our results, we would again call attention to the fact that we are dealing here with only one of the four questions that need to be answered before we can hope to fully understand the influence of alcohol on gastric digestion as a whole. Thus, our results afford plain evidence of the influence of alcohol on the digestive or solvent power of the gastric juice, but we should not be justified in arguing that exactly the same results would follow from the introduction of alcohol into the living stomach. The action of a given percentage of alcohol on proteolysis alone would be essentially the same in the stomach as in a beaker, provided the alcohol was not absorbed into the blood and thus removed from contact with the digestive mixture, and provided it did not exert any influence on the character of the gastric juice secreted. But it is easily conceivable that a percentage of alcohol which does not interfere with solution of the proteid foodstuffs may so modify the amount or character of the secretion that digestion might be greatly stimulated or greatly retarded. Further, as already stated, the presence of alcohol in the stomach may so affect absorption and peristalsis that the rate of digestion may be modified from this cause; hence, the results above recorded are to be used only in drawing conclusions as to the effect of various percentages of alcohol on the purely chemical process of gastric digestion, *i. e.*, on pepsin-proteolysis.

With reference to these other questions which have such an important bearing on gastric digestion we must await the appearance of more complete experimental data for their solution, and not until then can we explain fully the action of alcohol on digestion in the broad sense indicated.

In conclusion, it is to be noted that our results are more or less in accord with what has been previously published concerning the action of alcohol on gastric digestion. Thus, Bikfalvi[1] found in artificial digestive experiments that alcohol, even in small quantities, retards normal gastric digestion. Klikowicz[2] found that the presence of 5 per cent. of alcohol in the digestion of egg- and serum-albumin led to somewhat variable results, although, as a rule, there was an indication of a slight stimulation of proteolytic action. In the presence of 10 per cent. of alcohol there was always marked retardation, while 15, 20, and 30 per cent. of alcohol checked digestion to a marked degree.

Roberts found by artificial digestion-experiments that in the presence of less than 10 per cent. of proof-spirit there was no appreciable retardation. With 10 per cent. retardation was only barely detectable. With 20 per cent. there was quite distinct, but still only a slight, retardation. Above this point, however, the inhibitory effect of alcohol increased rapidly.[3]

That the action of a digestive ferment may be both stimulated and retarded by the same substance, according to the quantity present, has been already demonstrated;[4] hence there is no inconsistency in the above results with alcohol. The same action has likewise been observed with yeast-cells.[5]

ACTION OF WHISKEY.

Pure whiskey, as is well known, is simply "a diluted alcohol with a peculiar flavor or aroma, due to the raw material employed in its manufacture, and developed during the fermentation, distillation, and ageing of the liquor."[6]

Analysis of a large number of samples of whiskey made under the direction of the New York State Board of Health[7] has shown that adulteration is limited mainly to the addition of water and coloring matter, while such deleterious substances as fusel oils may be present in liquors which have not been properly rectified. Thus, the percentage of alcohol was found to vary from 28.9 per cent. by volume to 60.3 per cent. By far the larger number of samples analyzed showed a content of alcohol ranging from 35 to 40 per cent. by volume.

Our work on the influence of whiskey on gastric digestion was commenced by studying the influence of a medium quality of rye whiskey (Mount Vernon pure rye whiskey, $1 per quart), analysis of which gave the following results:

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[1] Jahresbericht für Thierchemie, xv. p. 273.

[2] Virchow's Archiv, Band 102, p. 376.

[3] Digestion and Diet, p. 132.

[4] Chittenden: Studies in Physiological Chemistry. Yale Univer. Vol. I. p. 76; also vol. 3, p. 60. Dubs: Virchow's Archiv, Band 134, pp. 519–540.

[5] Schultz: Pflüger's Archiv, Band 42, p. 517. Biernacki: Jahresbericht für Thierchemie, 17, p. 477.

[6] Second Annual Report of the New York State Board of Health, p. 642.

[7] Loc. cit., p. 647–648.

Specific gravity	0.937 at 17.5° C.
Alcohol, by volume	50–51 per cent.[1]
Solid residue at 110° C.	0.3284 gram per 100 c.c.
Ash	0.0040 " " "

Reaction acid.

Experiment 20.

Conditions:

Proteid = fluid egg-albumin (10 c.c.).
10 c.c. albumin solutin contain 0.8146 gram dry albumin.
0.03 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion 4½ hours at 38°–40° C.

Whiskey.	Undigested albumin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.0182 gram.	97.8 per cent.	100.0
3 "	0.0176 "	97.9 "	100.1
5 "	0.0288 "	96.6 "	98.7
8 "	0.0284 "	96.6 "	98.7
10 "	0.0384 "	95.3 "	97.4

Experiment 21.

Conditions:

Proteid = fluid egg-albumin (10 c.c.).
10 c.c. albumin solution contain 0.8146 gram dry albumin.
0.012 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion 6 hours at 38°–40° C.

Whiskey.	Undigested albumin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.0270 gram.	96.7 per cent.	100.0
1 "	0.0231 "	97.2 "	100.5
3 "	0.0333 "	96.0 "	99.2
5 "	0.0395 "	95.2 "	98.4
8 "	0.0616 "	92.5 "	95.6
10 "	0.0774 "	90.5 "	93.5

Experiment 22.

Conditions:

Proteid = fluid egg-albumin (15 c.c.).
15 c.c. albumin solution contain 1.0522 grams dry albumin.
0.0024 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion 5½ hours at 38°–40° C.

Whiskey.	Undigested albumin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.4007 gram.	62.0 per cent.	100.0
1 "	0.4263 "	59.5 "	95.9
3 "	0.4545 "	56.9 "	91.7
6 "	0.5372 "	49.0 "	79.0
Absolute alcohol.			
3 "	0.5146 "	51.1 "	82.4

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[1] Varying somewhat in different samples.

Experiment 23.

Conditions:

Proteid = blood-fibrin (2 grams).
0.016 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion $2\frac{3}{8}$ hours at 38°–40° C.

Whiskey.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3401 gram.	83.0 per cent.	100.0
1 "	0.3357 "	83.3 "	100.3
3 "	0.3401 "	83.0 "	100.0
6 "	0.3678 "	81.7 "	98.4

Experiment 24.

Conditions the same as in the preceding experiment:

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.2013 gram.	90.0 per cent.	100.0
5 " absol. alcoh.	0.2601 "	87.0 "	96.6
5 " whiskey	0.2312 "	88.5 "	98.3

In the following experiment six different samples of whiskey were employed, several of which were known to contain only 40 per cent. of alcohol, and their action contrasted with half the percentage of absolute alcohol:

Experiment 25.

Conditions:

Proteid = blood-fibrin (2 grams).
0.009 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion $1\frac{11}{12}$ hours at 38°–40° C.

Whiskey.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.6701 gram.	66.5 per cent.	100.0
20 "	0.9659 "	51.8 "	77.8
20 "	0.9849 "	50.8 "	76.3
20 "	1.0378 "	48.2 "	72.4
20 "	1.0156 "	49.3 "	74.1
20 "	1.0390 "	48.1 "	72.3
20 "	1.0735 "	46.4 "	69.7
Absolute alcohol.			
10 per cent.	1.0673 "	46.7 "	70.2

It is thus evident from these experiments that when digestive action is fairly vigorous, as in the presence of moderate amounts of pepsin (Experiments 20, 21, and 23), small percentages of whiskey have no retarding action whatever upon gastric digestion; indeed, there is even a slight suggestion of increased digestive action in the presence of 1–3 per cent. of whiskey, much the same as was observed in the experiments with absolute alcohol. In the presence of 20 per cent. of whiskey digestive activity may be reduced one-fourth. Further, the retardation which is produced by larger percentages of whiskey is approximately equal to the retarding action caused by half these percentages of absolute alcohol. In other words, the results would seemingly point to the contained alcohol as the main cause of the inhibition produced by the whiskey. In Experiment 22 we again have evidence of the greater retarding effect of both whiskey and alcohol when the gastric juice is weak, owing to the presence of a small amount of pepsin.

In order to determine more definitely the exact cause of the inhibitory action of whiskey on gastric digestion the following experiments were tried:

Experiment 26.

Conditions:

Proteid = fluid egg-albumin (15 c.c.).
15 c.c. albumin solution contain 1.0522 grams dry albumin.
0.0024 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion 5¾ hours at 38°–40° C.

Whiskey.	Undigested albumin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.5065 gram.	51.9 per cent.	100.0
1 "	0.5268 "	50.0 "	96.3
3 "	0.5496 "	47.8 "	92.1
6 "	0.6069 "	42.4 "	81.6
Whiskey residue.[1]			
1 per cent.	0.5105 "	51.5 "	99.2
6 "	0.4719 "	55.2 "	106.3

Experiment 27.

Conditions the same as in Experiment 25, except that the 15 c.c. of albumin solution contained 1.2219 grams of dry albumin, and the period of digestion was 4$\frac{1}{12}$ hours:

Whiskey.	Undigested albumin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.5552 gram.	54.6 per cent.	100.0
1 "	0.6239 "	49.0 "	89.7
3 "	0.6573 "	46.2 "	84.6
6 "	0.6883 "	43.7 "	80.0
9 "	0.7457 "	39.0 "	71.4
Whiskey residue.			
1 per cent.	0.5559 "	54.6 "	100.0
6 "	0.5705 "	53.4 "	97.8

Experiment 28.

Conditions:

Proteid = blood-fibrin (2 grams).
0.016 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion 2¼ hours at 38°–40° C.

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[1] The whiskey residue was prepared by simply concentrating a definite volume of whiskey on the water-bath until the alcohol and volatile matter were driven off, then making the residue up to the original volume with water. Hence, 1 per cent. residue means the residue contained in 1 per cent. of whiskey.

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.1759 gram.	91.3 per cent.	100.0
5 “ absol. alcoh.	0.2145 “	89.3 “	97.8
5 “ whiskey residue	0.1847 “	90.8 “	99.4

Experiment 29.

Conditions the same as in the preceding experiment, except that the period of digestion was $1\frac{3}{4}$ hours:

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.2032 gram.	89.9 per cent.	100.0
5 “ alcohol	0.2317 “	88.5 “	98.4
10 “ whiskey	0.2181 “	89.1 “	99.1
10 “ “ distil.[1]	0.2499 “	87.6 “	97.4
10 “ “ residue	0.2002 “	90.0 “	100.1

Experiment 30.

Conditions the same as in the preceding experiment, except that the period of digestion was 2 hours:

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.1970 gram.	90.2 per cent.	100.0
5 “ alcohol	0.2830 “	85.9 “	95.2
10 “ whiskey	0.3056 “	84.8 “	94.0
10 “ “ distil.	0.2336 “	88.4 “	98.0
10 “ “ residue	0.2027 “	89.9 “	99.6

Experiment 31.

Conditions the same as in the preceding experiment, except that the period of digestion was $1\frac{5}{12}$ hours:

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3867 gram.	80.7 per cent.	100.0
5 “ absol. alcoh.	0.4352 “	78.3 “	97.0
10 “ whiskey	0.4481 “	77.6 “	96.1
10 “ “ distil.	0.4274 “	78.7 “	97.5
10 “ “ residue dissolved in water	0.4968 “	75.2 “	93.1
10 per cent. residue dissolved in alcohol[2]	0.3604 “	82.0 “	101.6

If the detailed results obtained in these many experiments are carefully scrutinized it will be seen that the small amount of solid matter contained in whiskey—the so-called whiskey residue—has in the majority of cases little or no retarding action on gastric digestion. That there should be some variation is to be expected, owing to possible variations in the amount and character of this solid matter. Further, the residue obtained by evaporation of whiskey is not always completely soluble in water, and the action of this material may naturally be somewhat different when mixed with water than when dissolved in alcohol (see Experiment 31). Still the general conclusion seems to be warranted that, as a rule, the solid matter of the whiskey is not responsible for the retarding action of this fluid upon the chemical process of gastric digestion. Such action as the whiskey possesses is to be attributed mainly to the alcohol or other volatile matter it contains. At the same time it is to be noted that with a fairly active gastric juice (Experiments 29, 30, and 31), the amount of retardation even with 10 per cent. of whiskey is not great, any more than it is in the presence of 5 per cent. of absolute alcohol. When, however, the gastric juice is very weak from scarcity of the active ferment, as in Experiments 26 and 27, then even small amounts of whiskey exercise a very marked retarding effect upon the digestive process. Further, these two experiments plainly show that the retardation in these cases is due essentially to the volatile matter of the whiskey, and not to the solid matter contained in it. We may thus conclude, with Roberts,[1] that taking into account the quantity of whiskey commonly used dietetically with meals, the amount so consumed is not sufficient to appreciably retard the speed of gastric digestion. For, if the digesting mass in the stomach be estimated at 2 pounds, a wineglass (2 ounces) of whiskey added thereto would only equal 5 per cent. of proof-spirit (or 2.5 per cent. of absolute alcohol), an amount too small to hamper digestion to any appreciable extent. Even double such an amount, as Roberts says, would scarcely have any marked retarding effect upon pepsin-proteolysis. Hence, whiskey can be considered to impede the solvent action of the gastric juice only when taken immoderately and in intoxicating quantities.

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[1] The “whiskey distillate” was prepared by distilling a definite volume of whiskey nearly to dryness and making the distillate up to the original volume with water, the 10 per cent. whiskey distillate, therefore, meaning the volatile matter contained in that specific volume of whiskey.

[2] The whiskey residue obtained as already described, but dissolved in alcohol of the strength originally present in the whiskey instead of in water.

So much has been said and written about the widespread adulteration and falsification of whiskeys that we deemed it wise before leaving the subject to make a search for samples of this liquor which would show a wide variation from what might be called the normal standard. The results thus far reported were obtained with whiskeys containing 50 per cent. of alcohol by volume. Prof. James Babcock, in his first and second annual report as assayer of liquors to the commonwealth of Massachusetts, gives the strength of 257 samples of ordinary whiskey analyzed by him as varying from 30 to 59 per cent. of alcohol by volume. The few samples that we have purchased in New Haven and analyzed, however, have, with one or two exceptions, shown very little difference in their content of alcohol, although we took particular pains to obtain them from representative places. The character of these places may be indicated by their names.

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[1] Digestion and Diet, p. 133.

	Alcohol.
Sample A, from high-class grocer	50 per cent.
" B, " Canadian Club whiskey	42 "
" C, " saloon of better class	40 "
" D, " " of low order	44 "
" E, " " of low order	43 "
" F, " " known as the "dead-house"	42 "
" G, " " known as "Sneezer's"	40 "
" H, " " quite respectable	40 "
" I, " " McGraw's	30 "

With the exception of the first and last of these few samples there is very little variation in the content of alcohol. Digestion experiments tried with some of these whiskies gave the following results:

Experiment 32.

Conditions:

Proteid = blood-fibrin (2 grams).
0.015 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion 1¼ hours at 38°–40° C.

Whiskey.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.6131 gram.	69.4 per cent.	100.0
Sample I, 10 "	0.6591 "	67.1 "	96.6
" B, 10 "	0.6876 "	65.7 "	94.6
" G, 10 "	0.7469 "	62.7 "	90.3

Experiment 33.

Conditions practically the same as in the preceding experiment:

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.5945 gram.	70.3 per cent.	100.0
Whiskey D, 10 "	0.7711 "	64.5 "	91.7
" C, 10 "	0.7352 "	63.3 "	90.0
" F, 10 "	0.7609 "	62.0 "	88.1
" E, 10 "	0.8086 "	59.6 "	84.7
" H, 10 "	0.8659 "	56.8 "	80.7
Absol. alcoh. 5 "	0.8362 "	58.2 "	82.7

If we compare the action of these samples of whiskeys, we see (Experiment 32) that sample I, with the lowest content of alcohol, has the least inhibitory effect. On the other hand, in Experiment 33 there are greater differences in the retardation produced by these several varieties of whiskey than one would expect from the slight variations in the content of alcohol. This, however, we are inclined to attribute, in part at least, to the presence of variable amounts of tannin. In accordance with this idea, we found that among those samples with a like content of alcohol the presence of tannin was more conspicuous in the whiskeys with the greatest retarding action.

ACTION OF SO-CALLED FUSEL OILS ON GASTRIC DIGESTION.

So much has been written concerning the contamination of whiskeys and other liquors with fusel oil that we deemed it wise to give some thought to this matter in connection with our study of the influence of whiskey, brandy, and other liquors on the chemical processes of gastric digestion. It is a well-known fact that when fermented saccharine liquors are submitted to distillation there are obtained, in addition to water and ordinary or ethyl alcohol, small quantities of other alcohols, which are commonly known as fusel oil. Each raw material used in the preparation of a distilled liquor is supposed to have its own particular form of fusel oil. Hence, there is the potato fusel oil, sugar-beet fusel oil, rye fusel oil, corn fusel oil, grape fusel oil, etc., which contain in various proportions propyl, butyl, amyl alcohol, etc. Of these alcohols, amyl alcohol is said to be the most poisonous, and it is generally understood to be present in largest quantity in the whiskeys made from the potato. However this may be, the various constituents of these fusel oils react upon each other during the process of ageing, forming new and more volatile combinations which help give to the respective fluids their aroma and bouquet. Hence, in old whiskeys fusel oils should be entirely absent, and in all properly distilled and rectified spirits the amount of these substances should be at the most quite small. Indeed, so far as our own experience goes, we have never found more than traces of these so-called oils in the whiskeys or brandies that we have examined. But with a view to ascertaining the effect of such substances on gastric digestion, assuming them to be present in whiskeys and other like liquors, we have tried some experiments with the alcohols of this class, in order to ascertain how their possible presence would influence the chemical processes of digestion. The results may be briefly detailed in the following experiments:[1]

Experiment 34.

Conditions:

Proteid = blood-fibrin (2 grams).
0.02 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion 2 hours at 38°-40° C.

Amyl alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.5665 gram.	71 6 per cent.	100.0
0.10 "	0.5316 "	73.4 "	102.4
0.25 "	0.6176 "	69.1 "	96.4
0.50 "	0.6179 "	69.1 "	96.4
1.00 "	0.6887 "	65.5 "	91.4
2.00 "	0.8801 "	55.9 "	78.1

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[1] These experiments were carried out in our laboratory by Richard F. Rand, Ph.B.

Experiment 35.

Conditions the same as in the preceding experiments, except that the period of digestion was $1\frac{5}{8}$ hours:

Isobutyl alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.7225 gram.	63 8 per cent.	100.0
0.05 "	0.6580 "	67.1 "	105.0
0.10 "	0.7583 "	62.0 "	97.1
0.25 "	0.7993 "	60.0 "	93.9
0.50 "	0.8313 "	58.4 "	91.4
2.00 "	0.8451 "	57.7 "	90.4

Experiment 36.

Conditions the same as in the preceding experiment:

Propyl alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.6136 gram.	69.3 per cent.	100.0
0.05 "	0.5514 "	72.4 "	104.4
0.10 "	0.5025 "	74.8 "	108.0
0.25 "	0.4944 "	75.2 "	108.5
0.50 "	0.5872 "	70.6 "	101.9
2.00 "	0.6192 "	69.0 "	99.5

Larger percentages of propyl alcohol gave the following results, the conditions being the same as in the preceding experiment, except that the period of digestion was $2\frac{1}{4}$ hours:

Propyl alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.5323 gram.	73.3 per cent.	100.0
5 "	0.7804 "	60.9 "	82 1
10 "	1.6271 "	18.6 "	24.0
15 "	1.8829 "	5.8 "	9 0
20 "	1.9047 "	4.7 "	6.4

Experiment 37.

Conditions the same as in the preceding experiments, save that the period of digestion was $2\frac{1}{4}$ hours:

Methyl alcohol.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.4892 gram.	75.5 per cent.	100.0
0.5 "	0.4492 "	77.5 "	102.6
2.0 "	0.4325 "	78.3 "	103.7
3 0 "	0.5381 "	73.0 "	96.7
5.0 "	0.5333 "	73.3 "	97.0

When it is remembered that these alcohols, if present at all, are found in whiskeys and similar liquors only in small quantities—hardly more than traces—it is seen that their action on the chemical processes of gastric digestion cannot be very deleterious. Indeed, so far as our data show, the presence of traces of these alcohols tends to increase rather than to decrease the rate of digestive action. While they may be very undesirable impurities in alcoholic liquors, and may perhaps have many physiological properties detrimental to health, they certainly do not materially interfere with the chemical processes of gastric digestion. Physiologically, it is of interest to note how all of these alcohols, as well as ethyl alcohol, have the property of increasing the rate of digestive action when present in small amount. Also noticeable is the relationship between the position of the alcohol in the series and the extent of its stimulating and retarding action. Thus, methyl alcohol, the lowest member of the series increases the rate of proteolysis even when present to the extent of 2 per cent, while amyl alcohol produces stimulation only when present in amounts less than 0.2 per cent.

BRANDY.

According to Dr. Edward Smith, of England, "brandy is or should be the choicest and most agreeable member of the class of ardent spirits. It should be prepared by distillation from wine," but as is well known a large amount of the brandy consumed at the present time is simply alcohol distilled as in the preparation of whiskey, and flavored with oil of cognac. From this it may be inferred that brandy will have much the same action as whiskey on gastric digestion.

The brandy used in our first experiments was of good quality, known as Horne's cold distilled brandy, selling at $1.25 per quart. Analysis showed the following composition:

Specific gravity	0.940 (at 19° C.).
Alcohol by volume	47–48 per cent.
Solid residue at 110° C. . . .	0.0430 gram per 100 c.c.
Ash	0.0054 " " "
Reaction acid.	

Experiment 38.

Conditions:

Proteid = fluid egg-albumin (15 c.c.).
15 c c. albumin solution contain 1.3395 grams dry albumin.
0.006 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion 7 hours at 38°–40° C.

Brandy.	Undigested albumin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3962 gram.	70.5 per cent.	100.0
1 "	0.4379 "	67.4 "	95.6
3 "	0.5012 "	62.8 "	89.0
6 "	0.5218 "	61.1 "	66.6
Brandy residue.			
1 per cent.	0.3992 "	70.2 "	99.4
6 "	0.3654 "	72.8 "	103.2

Experiment 39.

Conditions:

Proteid = blood-fibrin (2 grams).
0.016 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion 2⅜ hours at 38°–40° C.

Brandy.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3401 gram.	83.0 per cent.	100.0
1 "	0.3306 "	83.5 "	100.6
3 "	0.3440 "	82.8 "	99.7
6 "	0.3433 "	82.9 "	99.8

Experiment 40.

Conditions the same as in the preceding experiment, except that the period of digestion was 2¼ hours:

Brandy.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.2013 gram.	90.0 per cent.	100.0
5 "	0.2251 "	88.8 "	98.7

Experiment 41.

Conditions the same as the above, except that the period of digestion was 1 7/12 hours:

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3247 gram.	83.8 per cent.	100.0
5 " absol. alcoh.	0.3554 "	82.3 "	98.2
10 " brandy	0.3752 "	81.3 "	97.0
10 " " distil.	0.3489 "	82.6 "	98.5
10 " " residue[1]	0.3024 "	84.9 "	101.3

Experiment 42.

Conditions the same as the above, except that the period of digestion was 1½ hours:

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3361 gram.	83.2 per cent.	100.0
5 " absol. alcoh.	0.4040 "	79.8 "	95.9
10 " brandy	0.4242 "	78.8 "	94.7
10 " " distil.	0.4286 "	78.6 "	94.4
10 " " residue in alcohol	0.4334 "	78.4 "	94.2
10 " " residue in water	0.3609 "	82.0 "	98.5

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[1] Dissolved in water, being the residue from this percentage of brandy.

Experiment 43.

In this experiment four distinct samples of brandy were used.

Conditions:
Proteid = blood-fibrin (2 grams).
0.009 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion 1½ hours at 38°–40° C.

Brandy.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.7941 gram.	60.3 per cent.	100.0
10 "	1.0007 "	50.0 "	82.9
10 "	0.9357 "	53.3 "	88.3
10 "	0.9304 "	53.5 "	88.7
10 "	0.9014 "	55.0 "	91.2

The experiments here recorded indicate that brandy has a slight retarding action on pepsin-proteolysis when present in quantities ranging from 5 to 10 per cent. When the gastric juice is relatively weak, then the retardation may be quite pronounced, as in Experiment 38. Such action as the brandy possesses is due almost wholly to the contained alcohol. Indeed, the solid matter present in brandy when separated and dissolved in water may even cause a slight increase in the rate of proteolysis. Evidently, we may draw the same conclusions regarding brandy that have been drawn in connection with whiskey. Both owe their action mainly to the contained alcohol; the results obtained with 10 per cent. of brandy being essentially the same as those obtained with 5 per cent. of absolute alcohol under like conditions.

RUM.

The only essential difference between whiskey and rum, as generally understood, is in the character of the aroma or flavor, and, as the volatile products which are the cause of the flavor are present only in very small quantity, it might be assumed that these two liquors would be very much alike in their general physiological action. The sample of rum (old St. Croix rum, at $1.25 per quart) with which our experiments were mainly made had the following composition:

Specific gravity	0.935 (at 18.5° C.).
Alcohol by volume	50.8–51.0 per cent.
Solid residue at 110° C. . . .	0.3068 gram per 100 c.c.
Ash	0.0070 " " "
Reaction acid.	

Experiment 44.

Conditions:
Proteid = blood-fibrin (2 grams).
0.016 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion 2¼ hours at 38°–40° C.

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.2013 gram.	90.0 per cent.	100.0
5 " rum	0.2304 "	88.5 "	98.3
5 " whiskey	0.2312 "	88.5 "	98.3
5 " absol. alcoh.	0.2601 "	87.0 "	96.6

Experiment 45.

Conditions the same as in the preceding experiment, except that the period of digestion was 1⅝ hours:

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.3995 gram.	80.1 per cent.	100.0
5 " absol. alcoh.	0.5392 "	73.1 "	91.2
10 " rum	0.5029 "	74.9 "	93.5
10 " " distillate	0.4561 "	77.2 "	96.3
10 " " residue in 50 pr. ct. alcoh.	0.4691 "	76.6 "	95.6
10 " rum residue in water	0.4290 "	78 6 "	98.1

Experiment 46.

Conditions the same as in the preceding experiment, except that the period of digestion was 2¼ hours:

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.1759 gram.	91.3 per cent.	100.0
5 " rum residue[1]	0.1589 "	92.1 "	100.8
5 " whiskey residue[2]	0.1847 "	90.8 "	99.4
5 " absolute alcohol	0.2145 "	89.3 "	97.8

The results plainly indicate that rum is essentially similar to whiskey in its action on artificial gastric digestion, and that such retardation as it causes is due mainly to the contained alcohol.

GIN.

Our experiments with this liquor were conducted solely with a sample of so-called "pure Holland gin," the composition of which was as follows:

Specific gravity	0.937 (at 16° C.).
Alcohol by volume	51.0 per cent.
Solid residue at 110° C. . . .	0.2968 gram per 100 c.c.
Ash	0.0090 " " "

Reaction very slightly acid.

Experiment 47.

Conditions:

Proteid = blood-fibrin (2 grams).
0.015 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion 1⅝ hours at 38°–40° C.

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[1] Residue dissolved in water.

[2] Ibid.

Gin.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.4210 gram.	79.0 per cent.	100.0
1 "	0.4722 "	76.4 "	96.7
3 "	0.4681 "	76.6 "	96.9
5 "	0.4938 "	75.4 "	95.4
10 "	0.5725 "	71.4 "	90.3
Absolute alcohol.			
5 per cent.	0.5506 "	72 5 "	91.7

Experiment 48.

Conditions:

Proteid = blood-fibrin (2 grams).
0.008 gram pepsin; 0.2 per cent. hydrochloric acid.
Period of digestion 1⅔ hours at 38°–40° C.

Fluid added.	Undigested fibrin.	Proteid digested.	Relative proteolytic action.
0 per cent.	0.9045 gram.	54.8 per cent.	100.0
10 " gin	1.0230 "	48.9 "	89.2
10 " " distillate	0.9961 "	50.2 "	91.4
10 " " residue[1]	0.9508 "	52.5 "	95.8
5 " absol. alcoh.	1.0104 "	49.5 "	90.3

[1] Dissolved in water.

The results plainly indicate an action on pepsin-proteolysis exactly analogous to that of the related fluids—whiskey, rum, and brandy. As in the case of the latter, such action as the gin possesses is to be ascribed solely to the contained alcohol; the action of 10 per cent. of gin, with its 50 per cent. of alcohol, being practically identical with that of 5 per cent. of absolute alcohol or 10 per cent. of proof-spirit.

(*To be continued.*)

REMARKS ON OPERATIONS ON THE GASSERIAN GANGLION, WITH A REPORT OF FIVE ADDITIONAL CASES.[1]

By W. W. Keen, M.D.,
PROFESSOR OF THE PRINCIPLES OF SURGERY AND OF CLINICAL SURGERY, JEFFERSON MEDICAL COLLEGE, PHILADELPHIA.

On February 14, 1894, I reported to this Society, in conjunction with Dr. John K. Mitchell, a case of tic douloureux, in which I operated on the Gasserian ganglion. The patient, after the lapse of twenty-six months, has remained entirely free from pain with the exception of some slight twinges of pain, which I am inclined now to attribute rather to nervousness than to a real return of his disorder.

The two methods of reaching the ganglion are, first, that devised by

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[1] Read before the Philadelphia County Medical Society, Dec. 11, 1895.